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(71) Applicant: MATSUSHITA MOBILE COMMUNICATION DEVELOPMENT CORPORATION OF U.S.A. [US/US]; Suite 2-407, 1225 Northbrook Parkway, Suwanee, GA 30024 (US).

(72) Inventor: ZUSMANIS, Eriks; 120 Ridge Road, Berkeley Lake, GA 30096 (US).

(74) Agent: SCHNEIDER, Ryan; Troutman Sanders LLP, Bank of America Plaza, Suite 5200, 600 Peachtree Street, N.E., Atlanta, GA 30308-2216 (US).

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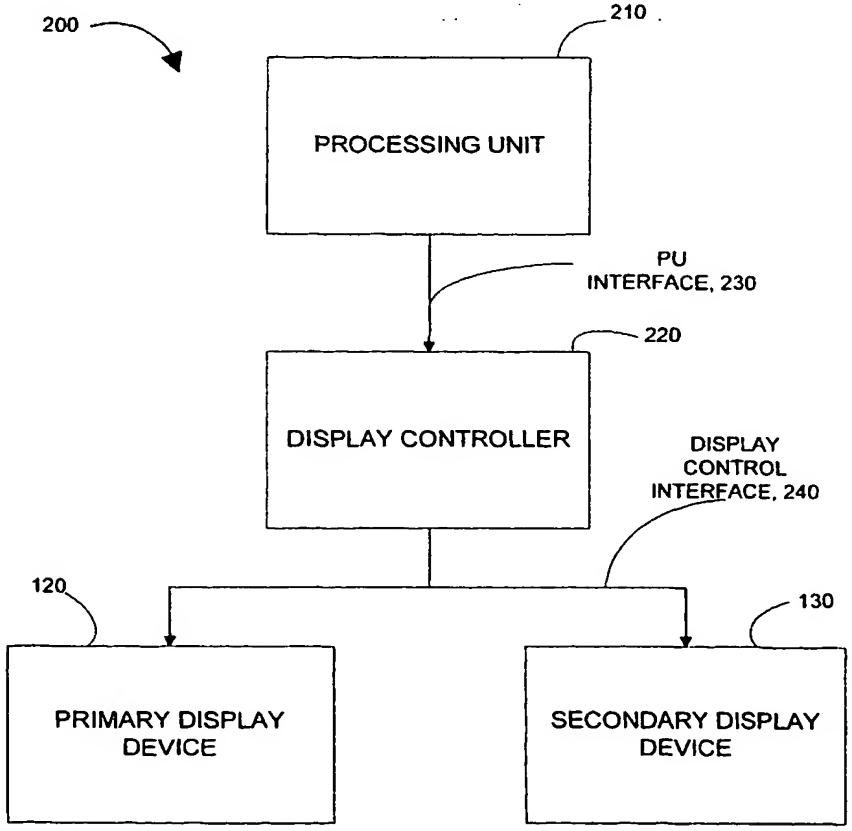
(54) Title: A SYSTEM AND METHOD FOR CONTROLLING MULTIPLE DISPLAYS



(57) Abstract: A multiple display device coordination system and method to provide a singular control mechanism for coordinating flashing display devices for a more coherent appearance. The control mechanism simplifies the control interface between the processing unit and multiple display devices by dedicating an extra common output line, normally associated with a primary display device, to a secondary display device. The secondary display device is then driven off of the common output line and from the same interface as the primary display device.

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A SYSTEM AND METHOD FOR CONTROLLING MULTIPLE DISPLAYS

TECHNICAL FIELD

The present invention relates to display control systems and, more specifically, to the control and coordination of flashing displays in a consumer product, such as a cellular telephone.

BACKGROUND OF THE INVENTION

Various display devices are used throughout the electronics industry to display information to a user. Some typical display devices are light emitting diodes (LEDs), liquid crystal displays (LCDs), CRTs, television screens, and other devices which are incorporated into many types of electronic products. Some electronic products that may use multiple display devices include cellular telephones, calculators, laptop computers, pagers, radar detectors, electronic thermostat displays, and electronic planners such as PalmOS™ devices and WindowsCE™ devices.

Generally, LEDs are used to provide status indicators such as: power on, charging, and low battery. On the other hand, LCDs are usually used to provide status messages, information and to implement the user interface for an electronic device. In a typical electronic product, such as a cellular telephone, the messages shown on the LCD may

include: telephone number to call, battery level indicators, roaming indicator, call received indicator, and other messages and indicators.

In the operation of an electronic device, it is often desirable to blink or flash the display devices. This is often used to emphasize certain messages such as the reception of a call or various error or status messages. It is a simple task to flash one of the display devices. However, it can be technically difficult to flash or blink multiple display devices on a single electronic product in a coordinated or synchronized manner without complex timing circuitry. Presently, most electronic products utilize complex timing equations to make the LED and LCD appear to flash at the same time. However, this solution is tedious and undesirable.

The difficulties in coordinating or synchronizing display devices of a single electronic product can be demonstrated by examining an electronic product that utilizes an LED and an LCD, such as a cellular telephone. The difficulties encountered in coordinating the blinking or flashing of both the LED and the LCD arise from the interfaces between the Processing Unit (PU) and the various displays. Generally, the LCD is driven by an LCD controller. This LCD controller generally interfaces with the PU through the system bus or a serial port. The LED is generally driven through an I/O port of the PU. The I/O port operates at a different speed from the system bus and thus a blinking command executed on either the I/O port or the system bus will not appear on the LED or LCD, respectively, to be synchronous. This results in differences in the flashing rates that are perceptible to the human eye.

Therefore, there is a need in the art for a reliable system and method to coordinate and synchronize multiple display devices of a single electronic product in a simple and coherent manner.

SUMMARY OF THE INVENTION

The present invention solves the above-identified problems by providing a system and method of coordinating multiple displays relative to each other. The present invention seeks to provide a system and method of coordinating and synchronizing multiple display devices of a single electronic product by utilizing a single control mechanism to coordinate the control of the display devices.

Generally described, the present invention operates within a single electronic product having primary and secondary display devices such as a LCD and a LED, a processing unit, and a display controller. A standard LCD controller is used to communicate with both an LCD and an LED. Because current graphics LCD drivers/controllers typically contain more common drive outputs than are required for the LCD, the extra control lines on the LCD controller may be utilized to interface with the LED. The control lines are excited synchronously with the other LCD control lines. By exciting the LED and the LCD with a common set of control signals, the excitation is coordinated.

In accordance with one aspect of the invention, the system also utilizes a display driver to convert the LCD controller control line signals to a voltage level sufficient to illuminate the LED. Alternatively, the display controller may be capable of directly driving every display device. In such case, the display driver would not be required.

The foregoing has outlined rather broadly, the more pertinent and important features of the present invention. The detailed description of the invention that follows is offered so that the present contribution to the art can be more fully appreciated. Additional features of the invention will be described hereinafter. These form the subject of the claims of the invention. It should be

appreciated by those skilled in the art that the conception and the disclosed specific embodiment may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present invention. It should also be realized by those skilled in the art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram illustrating an exemplary embodiment of the present invention within a cellular telephone product.

Fig. 2 is a system block diagram illustrating an exemplary embodiment of the invention.

Fig. 3 is a list of the display control signals in an exemplary embodiment of the present invention utilizing an LCD controller.

Fig. 4 is a block diagram illustrating the use of a display driver in an exemplary embodiment of the invention.

Fig. 5 is a schematic diagram of the secondary display device adapted for use in an exemplary embodiment of the present invention.

Fig. 6 is a flow chart illustrating an exemplary embodiment for performing the processes of the present invention.

DETAILED DESCRIPTION

The present invention permits coordination and synchronization of multiple display devices on a single electronic product. One aspect of the present invention includes providing a single control mechanism for coordinating the multiple display devices. Another aspect of the present invention includes simplifying the control interface to provide accurate coordination of multiple display devices.

Although the present invention may be utilized in a variety of applications, the operation and feasibility of the present invention will be demonstrated by describing a specific embodiment. Alternate exemplary embodiments of the present invention can exist on many other types of electronic products that utilize multiple display devices including calculators, laptop computers, pagers, radar detectors, electronic thermostat displays, and electronic planners such as PalmOS™ devices and WindowsCE™ devices.

One embodiment of the present invention is a cellular telephone that includes at least one display device capable of displaying glyphs, such as a LCD. A glyph is a symbol that conveys information non-verbally. The invention also includes a second display device that can be another glyph oriented display device or it can be any other display device such as a two-state LED or a light bulb. While the preferred embodiment is described with reference to LEDs and a LCD, it is understood that other types of display devices may be utilized such as, but not limited to, light bulbs, CRTs, televisions, matrix boards, and jumbo-trons.

Most current graphics LCD drivers/controllers typically contain more common drive outputs than are required for the display. Even when some of the extra common outputs are used, applications rarely utilize all of the segment outputs associated with them. Therefore, a common output line, normally associated with the LCD, may instead be dedicated to a secondary display device. This LED dedicated common line is used to latch the state of the segment lines. The state of the latched segment lines is then used to gate the LED drivers or drive the LED directly. This allows both display devices to be driven from the same interface to the PU without using ports beyond those used to communicate

with the LCD controller. Therefore, the display devices are easily coordinated with one another because the state changes are written to the same LCD controller RAM.

Referring now to the drawing in which like numerals indicate like elements throughout the several views, Fig. 1 illustrates an exemplary embodiment of a cellular telephone **100**. Generally described, the cellular telephone **100** includes a keypad **110**, LCD **120**, a plurality of LEDs **130**, and an antenna **140**. The LED **130** may be any size or color and the LCD **120** is preferably a 64 x 132 pixel LCD **120**. However, those skilled in the art will also appreciate that any size LCD **120** or other display device may be used.

Fig. 2 illustrates a system block diagram **200** implementing one embodiment of the present invention. The system **200** includes a processing unit (PU) **210**, a display controller **220**, a block diagram representation of the LEDs **130**, and a block diagram representation of the glyph oriented display device or LCD **120**. Preferably, the display controller **220** is an LCD controller such as the SED1565 LCD driver with RAM marketed by EPSON™. Those skilled in the art understand that a variety of controllers may be used within various embodiments of the present invention including, but not limited to, LCD drivers, video drivers, or other display drivers.

The PU **210** is electrically coupled to the display controller **220** over a PU interface **230**. The PU interface **230** may be a serial port, I/O port, parallel port, system bus or any other PU interface. The PU **210** transmits display commands and information to the display controller **220** across the PU interface **230**. One skilled in the art is familiar with the various methods of interfacing to PU **210**.

The display controller **220** is electrically coupled to the LCD **120** and the LEDs **130** over a display control interface **240**. Display control requests are received on the display controller **220** and the display controller **220** then communicates with the display devices **120, 130** via the display control interface **240**. The display control requests represent display states for the display devices.

For example, when controlling or synchronizing a LCD and a LED connected to a common set of control lines of the display controller **220**, the display controller receives a display control request. The display control request represents a display state for the LCD as well as the LED. The display control lines are then controlled in accordance with the display control request to place the LCD and LED in the requested display state at substantially the same time. In the event the display controller receives a second display control request representing a second display control state for the LCD and LED, the display control lines are then controlled in accordance with the second display control request to place the LCD and LED in the second display state at substantially the same time. In other words, the display controller synchronizes the timing between switching the display devices between multiple display states. The display control lines may then be controlled to toggle the display devices between different display states.

The operation of the LCD **120** is controlled through the LCD controller **220**. LCD controllers commonly use certain signals to control the operation of the pixels on the LCD display. A typical LCD controller includes segment (SEG) lines and common (COM) control lines. These two sets of signals establish a matrix. The COM lines control the rows, and the SEG lines control the columns. Through these two sets of signals, the entire display can be controlled.

Fig. 3 is one embodiment of a list of display control signals from the display control interface **240** for utilizing the LCD controller **220**. SEG0-SEG131 and COM0-COM63 control the illumination of the pixels of the LCD **120**. These signals map the entire LCD **120** and allow for control of each individual pixel. In addition, typical LCD controllers include various control lines such as D0-D7, A0, E, and R/W. These control lines are used to configure and instruct the LCD **120** regarding what images to display. The SED1565 includes SEG0 - SEG131, COM0 - COM63, D0 - D7, A0, E, R/W and an additional COM signal, COMS. Some LCD controllers include the ability to control static icons. The SED1565 uses the COMS line to drive static icons. The present invention uses the COMS signal to drive the secondary display device **130**.

The display control lines of the display control interface **240** include any signals used to interface to and to control the display devices **120, 130**. The exact commands required for interfacing with a display controller will vary for each display controller **220**. The commands to be used with the SED1565 in this exemplary embodiment can be found in the data sheets associated with the SED1565 that are provided by EPSON™. The commands for controlling the COMS signal are identical to those for controlling the other COMX signals.

In certain embodiments of the present invention, the display controller **220** may not output control signals capable of driving both of the display devices **120, 130** directly. In such case, a display driver may be used to convert the display controller signals to levels capable of driving the second display device **130**.

Fig. 4 is a block diagram **400** illustrating the use of a display driver **410** in an exemplary embodiment of the invention. The display driver **410** is electrically coupled to the display controller **220** and the

display devices **120, 130**. The input of the control lines is latched to the second display device **130** with the display driver **410**. The display driver **410** receives the display control signals from the display controller **220** and provides a signal capable of driving the display devices **120** and/or **130**.

Fig. 5 is a schematic diagram **500** illustrating an exemplary display driver for use in driving an LED display device **130**. In operation, the display controller **220** transmits control signals to the display driver **410**. The display driver **410** converts the control signals to a voltage level and format capable of driving the LED **130**. The conversion to the appropriate voltage and format may preferably be performed by using a D flip-flop **510**. However, the display driver **410** may be excluded if the display controller **220** outputs a voltage capable of driving the display device **130**. Alternatively, other flip-flops such as RS flip-flops or JK flip-flops may be utilized. Also, a pull-up resistor may be utilized to alter the voltage level if the display controller **220** COMS output.

In the preferred embodiment, a SEG signal **520** is the input to the D-Flip Flop **510**, and the COMS signal **530** clocks in the value. Those skilled in the art are familiar with various methods of latching the control signals to drive display devices. Also, those skilled in the art are able to filter and/or amplify the signal if the control signal is not provided by the display controller **220** in a state capable of driving display devices. When the D-Flip Flop **510** latches the SEG signal **520**, it outputs a display drive signal **540**. The display drive signal **540** is used to control the LED **130**.

In an alternative embodiment, a display controller **220** that does not provide an extra COM control line may be utilized in the present invention. This can be done by setting aside one or more pixels on the primary display and using the control lines for those pixels to control the

secondary display device **130**. One way to implement this alternative embodiment would be to leave one row or column of the LCD **120** unused. This is easily done by leaving a blank row at the top, bottom, or between two text segments. The COMX signal for the discarded row is then routed to the display driver **410**. The display driver **410** then uses that COMX and any SEGX line to drive the LED **130**. One LED **130** may be driven for each SEGX available. However, additional LEDs **130** could be driven if additional COMX lines were dedicated to controlling the LEDs **130**.

Fig. 6 is a flow chart of a method **600** for coordinating multiple display devices. In the embodiment shown in Fig. 6, process block **610** is entered when the system detects that it is in a state where it must display information on multiple displays. In response to detecting the requirement of displaying data on multiple displays in block **610**, display data for a first display state is loaded into the display controller **220** as shown in block **620**. The data loaded into the display controller **220** includes the display data for both the glyph oriented display, LCD **120**, and the secondary display, LED **130**. Once the data is loaded into the display controller **220**, the system must wait for a delay **630** while the display controller **220** displays the information on the two display devices **120, 130**. After the delay **630**, the system will load the display data for a second display state into the display controller **220**, as shown in block **640**, and then wait for a second delay period **650**. Blocks **640** and **650** are identical to blocks **620** and **630**, respectively. By loading all of the display data into the display controller **220** and then waiting for the display controller **220** to display the data on the display devices **120** and **130**, the system is able to coordinate the multiple display devices **120, 130**.

After displaying the information on the display devices, an inquiry is conducted at decision block **660** to determine whether the system is still in a multiple display state. If the system is still in the multiple display state, the system will repeat the display procedures. Otherwise, if the system is no longer in the multiple display state, the process proceeds to block **670** where it will end until another multiple display state is detected.

From the foregoing description, it will be appreciated that the present invention provides a multiple display device coordination system to provide a singular control mechanism for coordinating multiple display devices. The present invention has been described in relation to particular embodiments which are intended in all respects to be illustrative rather than restrictive. Those skilled in the art will understand that the principles of the present invention may be applied to, and embodied in, various combination of hardware and software with various types of interfaces and transmission technology. Alternative embodiments will become apparent to those skilled in the art to which the present invention pertains without departing from its spirit and scope. Accordingly, the scope of the present invention is described by the appended claims and supported by the foregoing description.

CLAIMS

We claim:

1. A system for coordinating the display timing of multiple display devices, comprising:

a first display device;

a second display device; and

a display controller electrically coupled to and controlling the operation of the first display device and the second display device, wherein the display timing of the first and second display devices are coordinated relative to each other.

2. The system of claim 1 wherein the first and second display devices are electrically coupled to the display controller through display control lines for transmitting the display control signal to the first and second display devices.

3. The system of claim 1 wherein the first display device is a liquid crystal display.

4. The system of claim 1 wherein the second display device is a light emitting diode.

5. A system for controlling multiple display devices, comprising:

a first display device wherein the first display device is a glyph oriented display;

a second display device;

a display controller electrically coupled to the first display device and the second display device, wherein the display timing of the first and second display devices can be accurately controlled relative to each other; and

a display driver electrically coupled to the display controller and the second display device wherein the display driver, receives control signals from the display controller, and converts the control signals to a format compatible with the second display device.

6. The system of claim 5, wherein the display driver is a latch.

7. A method for controlling multiple display devices comprising:

connecting a first display device and a second display device to a common set of display control lines of a display controller;

receiving a first display control request on the display controller, the first display control request representing a first display state for both the first display device and the second display device; and

controlling the display control lines in accordance with the first display control request to place the first display device and the second display device in the first display state at substantially the same time.

8. The method of claim 7, wherein the display controller initiates a flash by toggling the first and second display devices in and out of the first display state.

9. The method of claim 7, further comprising the steps of:

receiving a second control request on the display controller, the second display control request representing a second display state for both the first display device and the second display device; and

controlling the display control lines in accordance with the second display control request to place the first display device and the second display device in the second display state at substantially the same time.

10. The method of claim 9, further comprising the step of:

controlling the display control lines to toggle the first display device and the second display device between the first state and the second state.

11. The method of claim 7, wherein the second display device is a two-state device, the method further comprising the step of:

controlling the display control lines to toggle the first display device and the second display device between the first display state and a second display state.

12. A method for controlling multiple display devices comprising:

connecting a first display device and a second display device to a common set of display control lines, wherein the first display device is a glyph oriented display device;

receiving a display control request on a display controller;

controlling the display control lines;

latching an input of the display control lines to the second display device with a display driver; and

coordinating the first and second display devices relative to each other.

13. A method for controlling the operation of multiple display devices in a synchronous manner, the method comprising the steps of:

sending a first set of display data to a display controller, the first set of display data including information representing a first display state for both a glyph oriented display device and a secondary display device;

sending a second set of display data to the display controller, the second set of display data including information representing a second display state for both the glyph oriented display device and the secondary display device; and

synchronizing the timing between switching the glyph oriented display device and the secondary display device between the first and second display states utilizing a simple display controller.

14. A method of controlling multiple display devices of a single electronic device, the method comprising the steps of:

setting aside one or more pixels on a LCD as unused; and

utilizing a control line associated with the set aside pixel to control a LED by routing the control line to a display driver to drive the LED.

15. A method of controlling multiple display devices of a single electronic device, the method comprising the steps of:

detecting a multiple display state requiring information be displayed on one or more display devices of the electronic device;

loading display data for a first display state into a display controller; and

outputting control signals from the display controller for driving the display devices wherein the signal of a control line associated with one of the display devices is coordinated with the signal of the control line of another of the display devices such that the display devices are synchronized for displaying the display data for the first display state.

16. The method of Claim 15 further comprising the steps of:

loading display data for a second display state into the display controller; and

outputting control signals from the display controller for driving the display devices wherein the signal of the control line associated with the one of the display devices is again coordinated with

the signal of the control line of the other display device such that the display devices are again synchronized for displaying the display data for the second display state.

17. A system for controlling multiple display devices, comprising:

an LCD;

an LED; and

a display controller having a plurality of SEG lines and a plurality of COM lines to control the LCD, wherein at least one of the COM lines in conjunction with at least one of the SEG lines is utilized to control the LED such that a display state of the LED can be coordinated with a display state of the LCD to allow the LED to flash in coordination with the LCD.

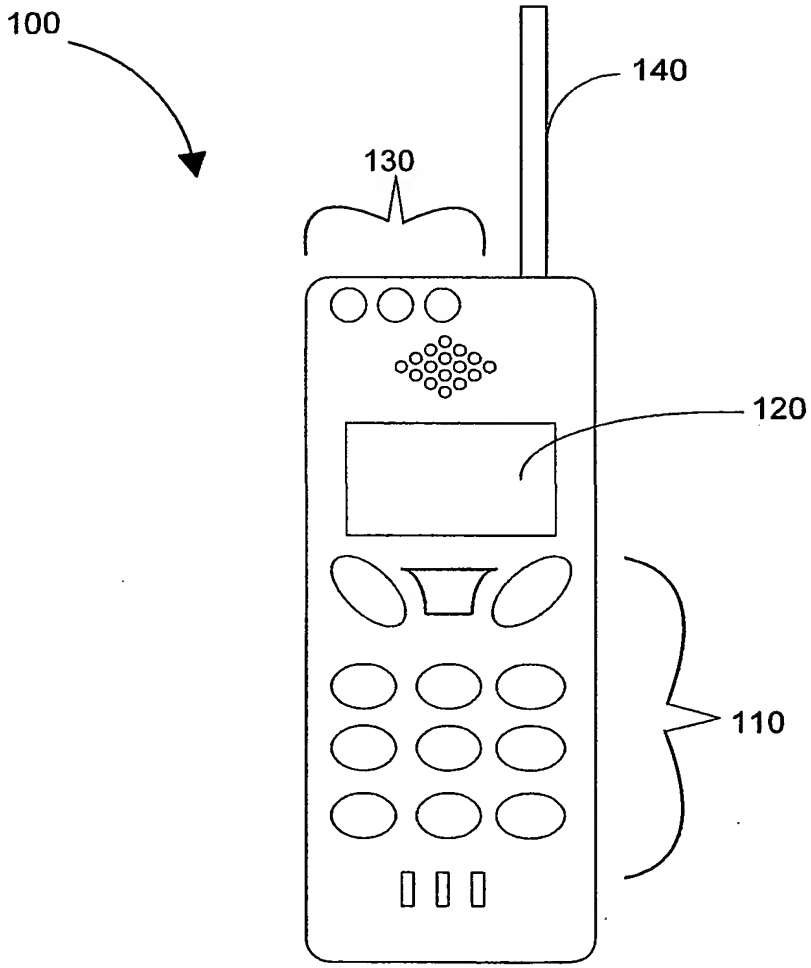

Fig. 1

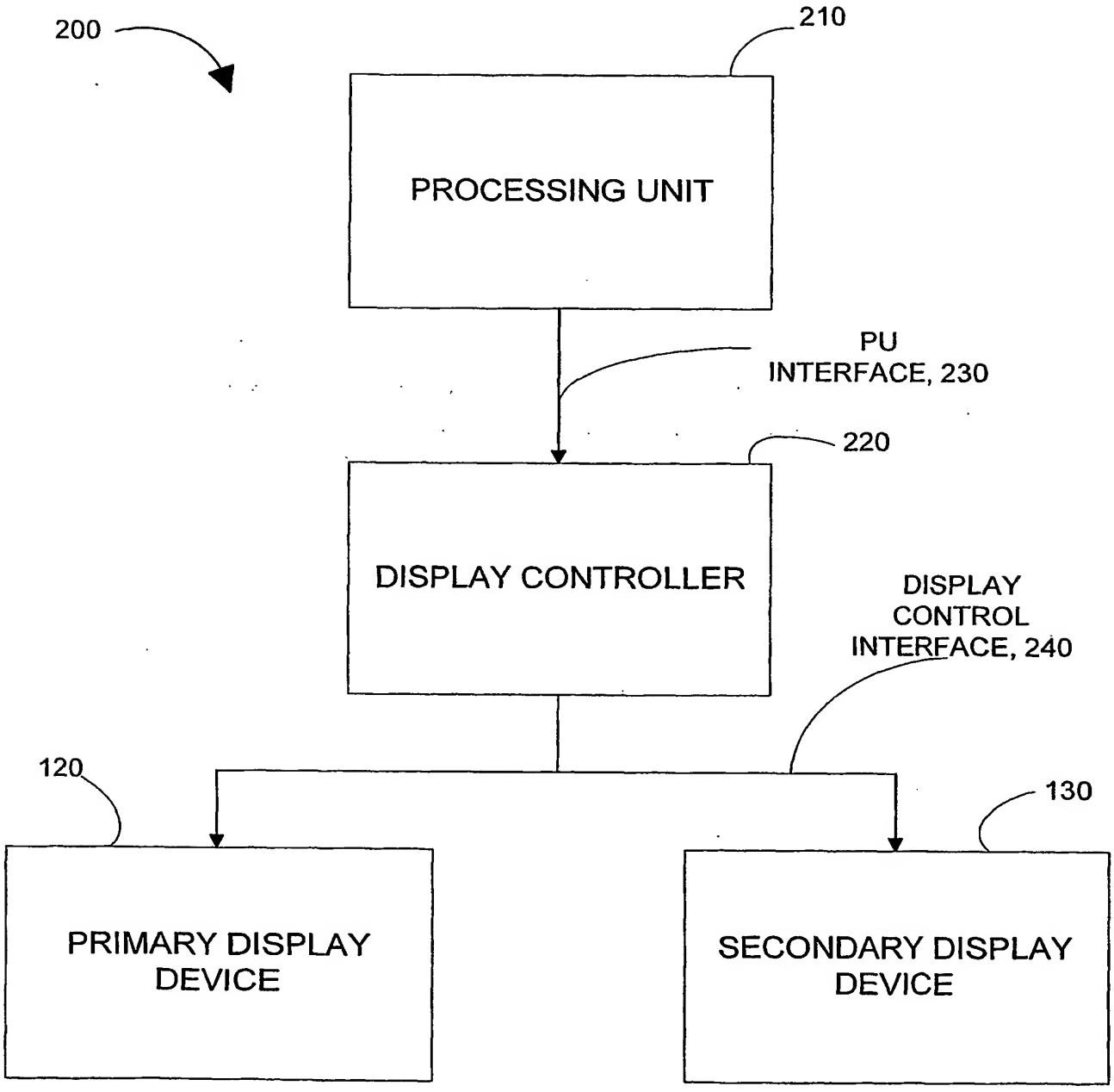
200
210
PROCESSING UNIT
PU
INTERFACE, 230
220
DISPLAY CONTROLLER
DISPLAY
CONTROL
INTERFACE, 240
120
130
PRIMARY DISPLAY
DEVICE
SECONDARY DISPLAY
DEVICE

Fig. 2

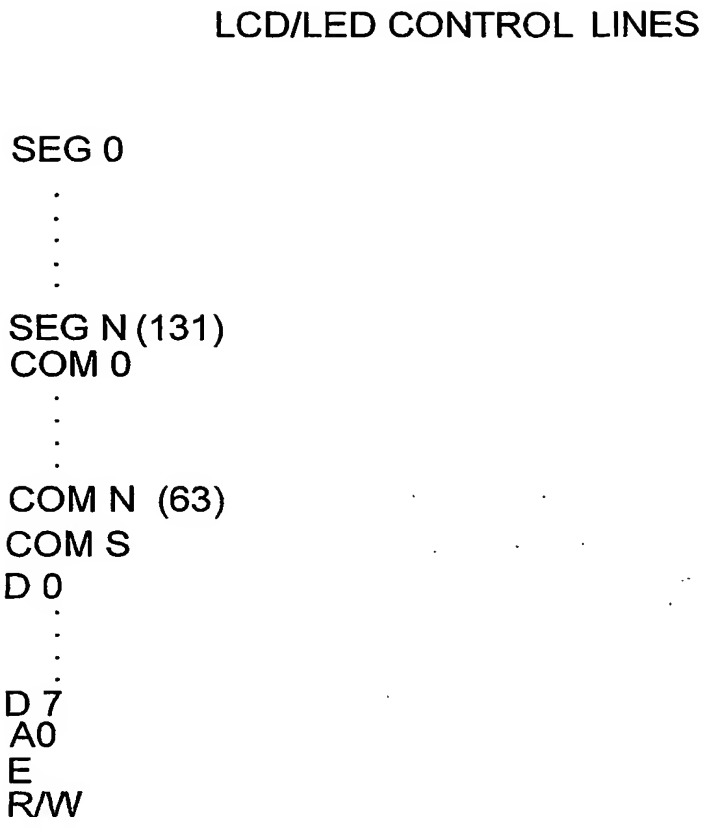
LCD/LED CONTROL LINES
SEG 0
SEG N (131)
COM 0
COM N (63)
COM S
D 0
D 7
A0
E
R/W

Fig. 3

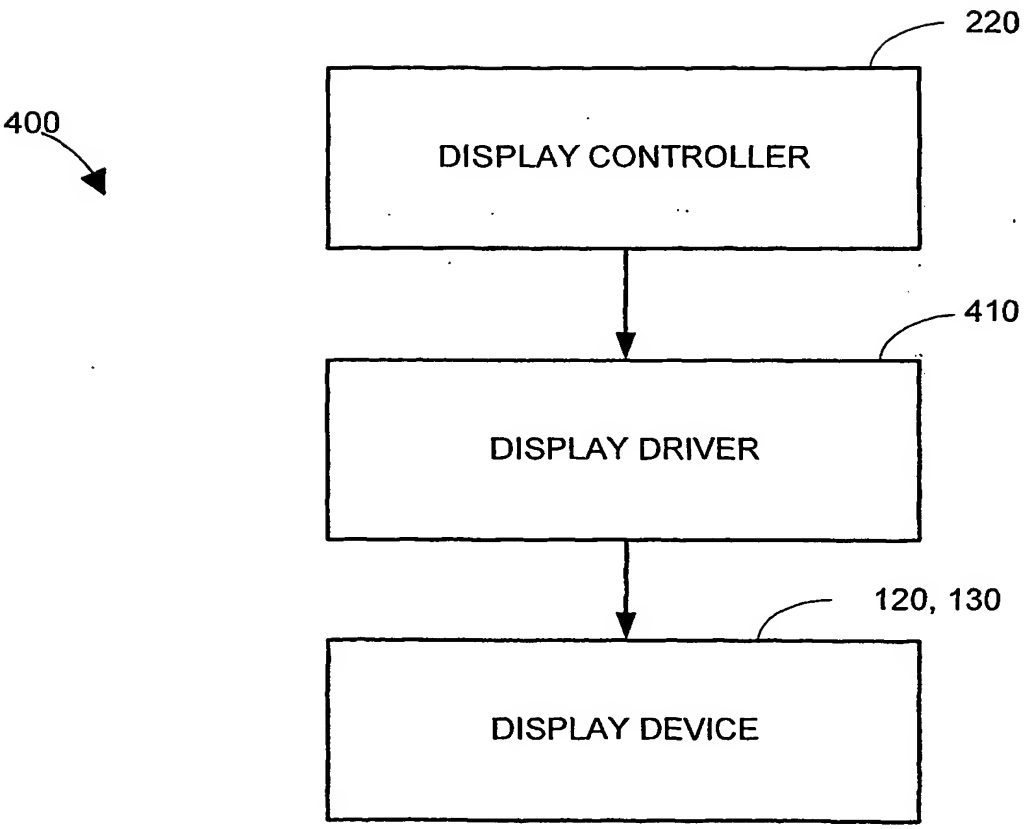
400
220
DISPLAY CONTROLLER
410
DISPLAY DRIVER
120, 130
DISPLAY DEVICE

Fig. 4

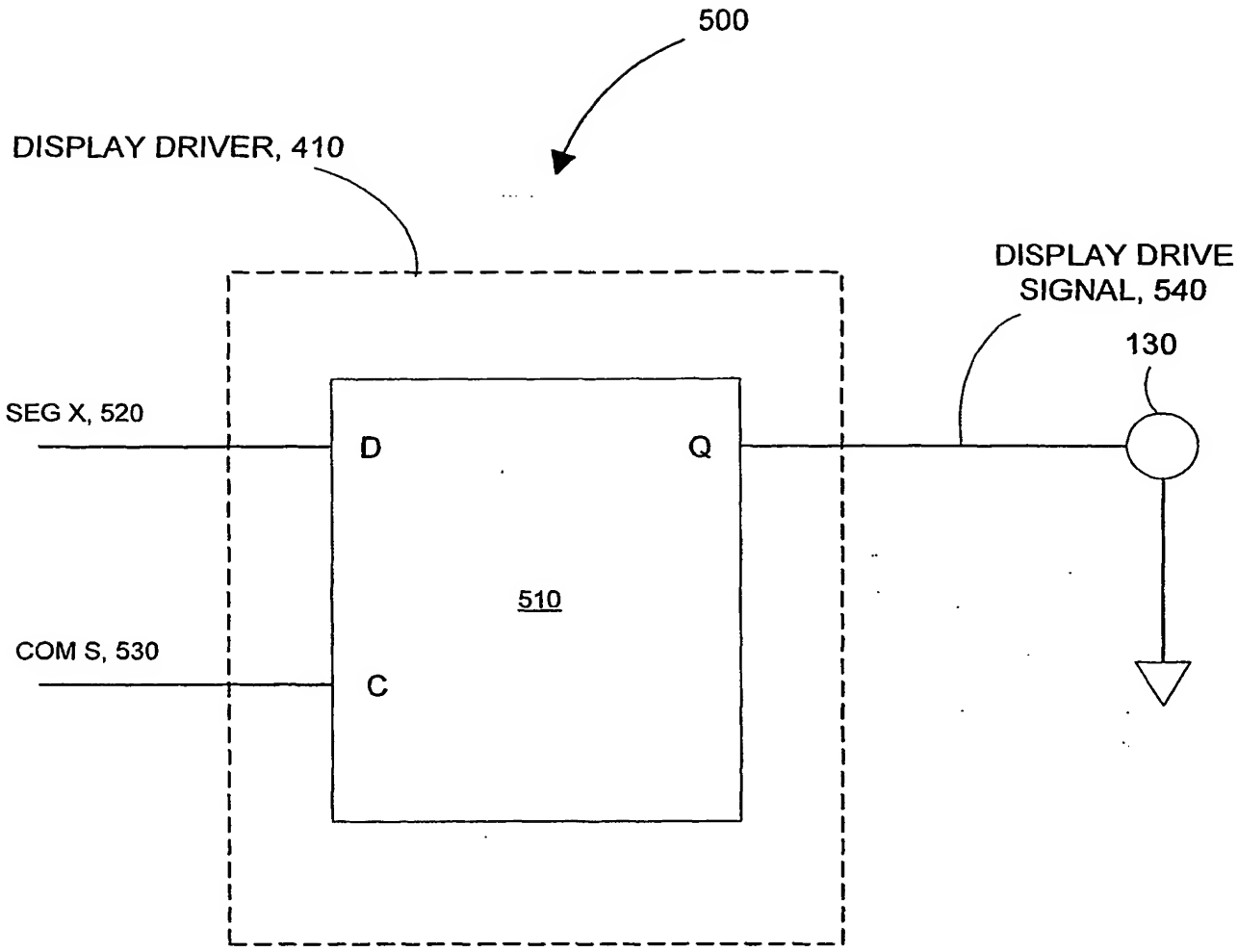
500
DISPLAY DRIVER, 410
DISPLAY DRIVE SIGNAL, 540
130
SEG X, 520
D
Q
510
COM S, 530
C

Fig. 5

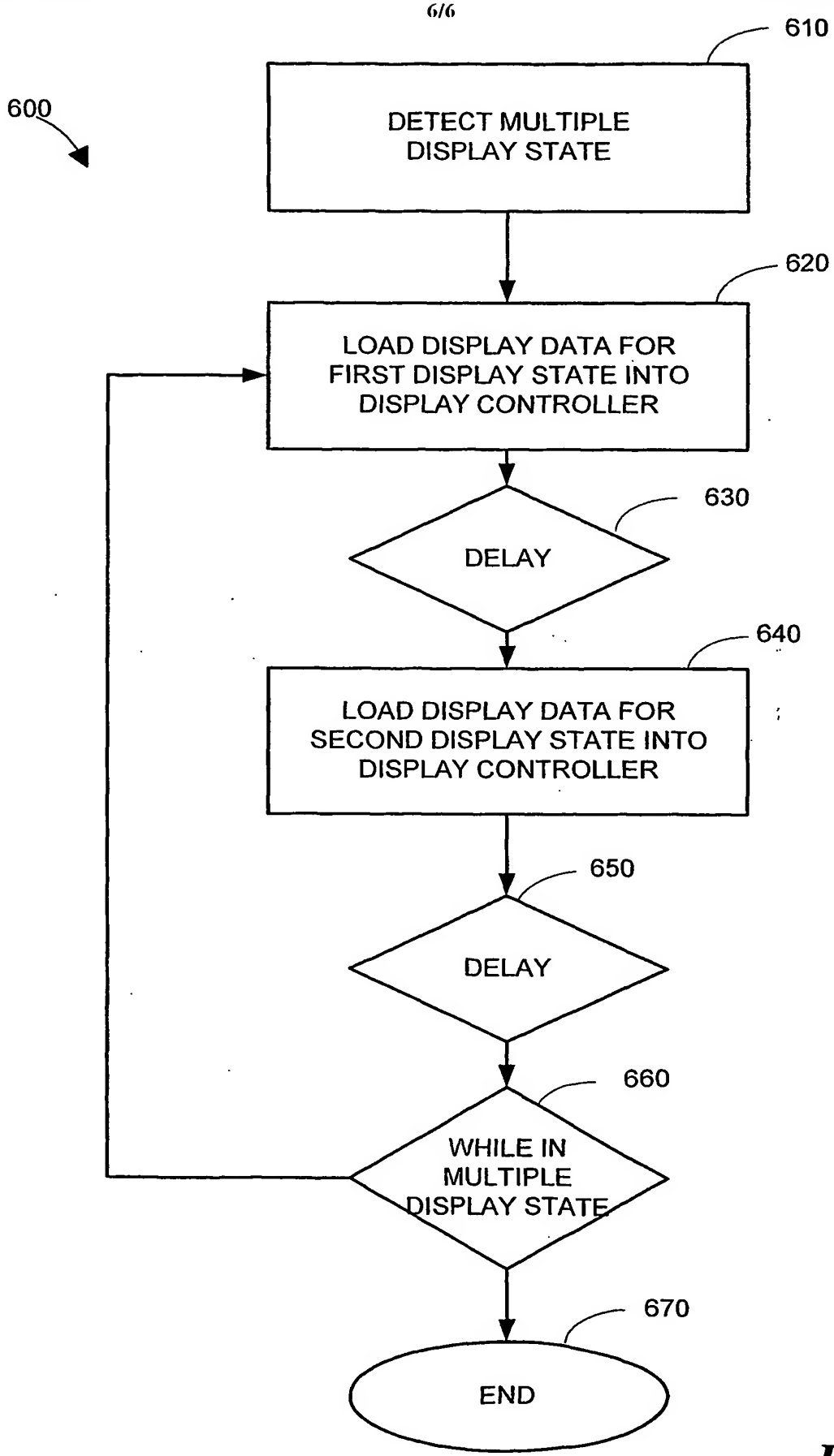

Fig. 6

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(72) Inventor: ZUSMANIS, Eriks; 120 Ridge Road, Berkeley Lake, GA 30096 (US).

(74) Agent: SCHNEIDER, Ryan; Troutman Sanders LLP, Bank of America Plaza, Suite 5200, 600 Peachtree Street, N.E., Atlanta, GA 30308-2216 (US).

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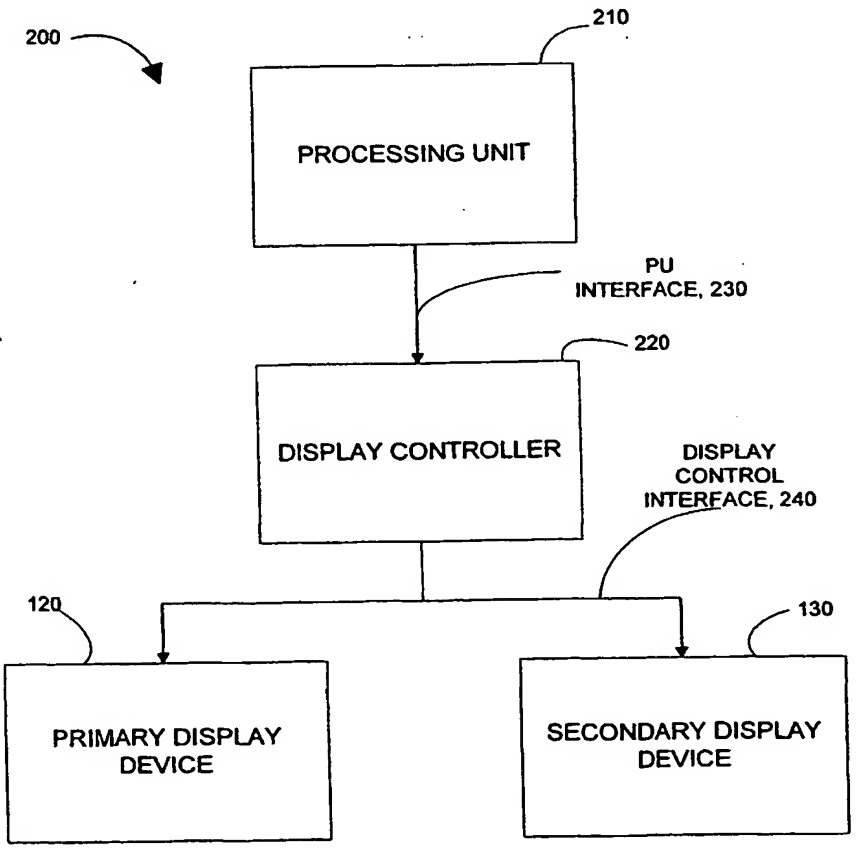
(54) Title: A SYSTEM AND METHOD FOR CONTROLLING MULTIPLE DISPLAYS



(57) Abstract: A multiple display device coordination system (200) and method to provide a singular control mechanism for coordinating flashing display devices for a more coherent appearance. The control mechanism simplifies the control interface (240) between the processing unit (210) and multiple display devices (120, 130) by dedicating an extra common output line, normally associated with a primary display device (120), to a secondary display device (130). The secondary display device (130) is then driven off the common output line and from the same interface as the primary display device (120).

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/20841

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04B 1/38
US CL :455/566, 90; 345/84, 87
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/566, 90; 345/84, 87, 169, 170

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2,326,051 A (JAHAGIRDAR et al) 12 September 1998, page 1, lines 5-10, page 6, lines 28-35 through page 7, lines 1-24, figs. 1 & 2, abstract, fig. 5 at 130, 132, 504, 516, 518, 520, page 8, lines 3-12, fig. 7, page 8, lines 13-35 through page 9, lines 1-14, figs. 8A & 8B.	1-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 06 SEPTEMBER 2001	Date of mailing of the international search report 31 DEC 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 872-9314	Authorized officer UCHENDU O. ANYASO Telephone No. (703) 306-5934

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